Stars shrouded in iron dust

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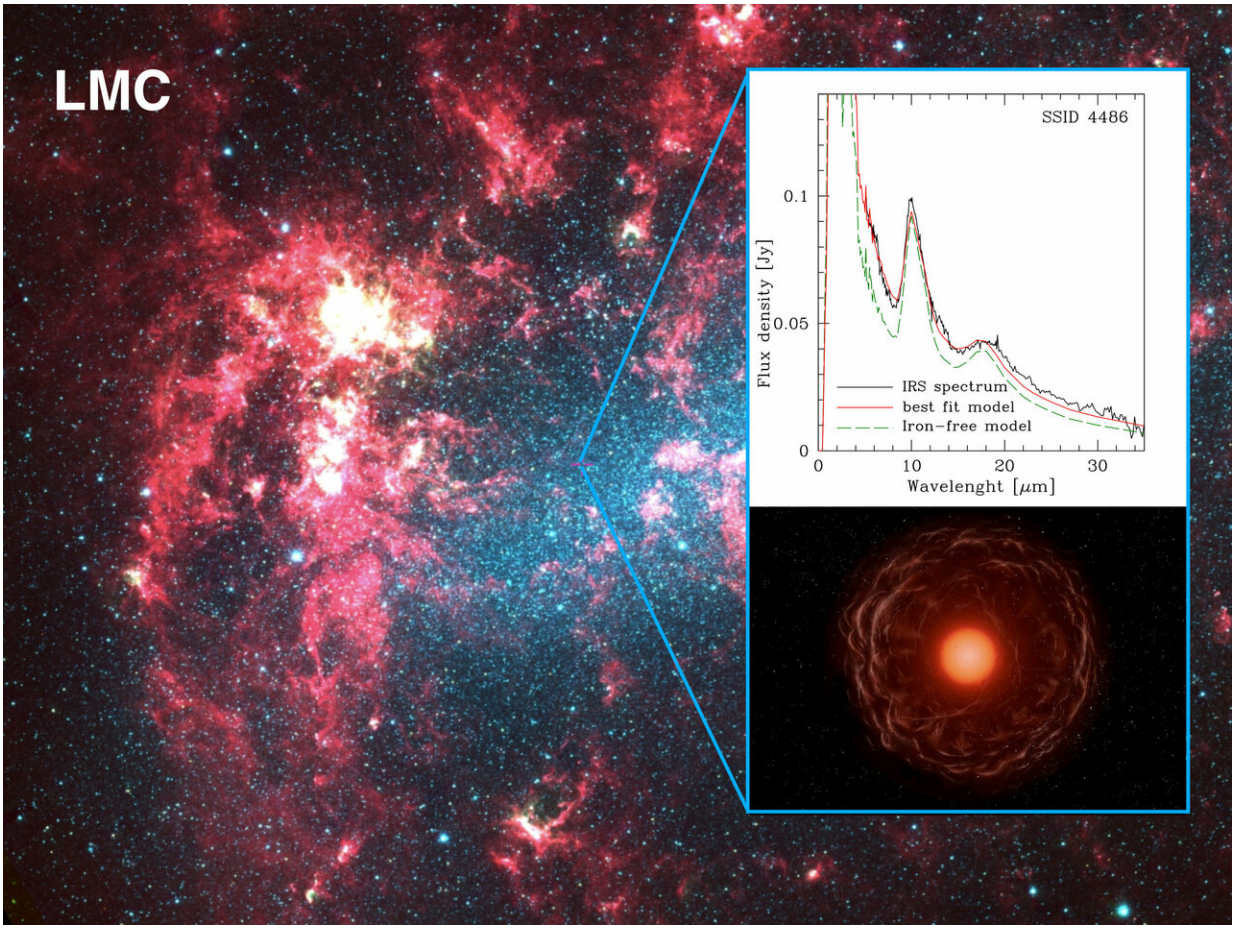

Infrared image of the Large Magellanic Cloud (LMC) as obtained with the Spitzer Space Telescope. Upper inset: the comparison between the Spitzer/IRS spectrum (black solid line) of the star SSID 4486 and the best fit theoretical spectrum of a 5 solar mass AGB star (red solid line) surrounded by ~70 percent of iron dust; the green dashed line refers to the corresponding theoretical spectrum of the same model without iron dust. Lower inset: artist's impression of a giant AGB star ejecting matter to the interstellar medium. Credit: LMC image: Aladin-software in Spitzer colors; Artistic image: JAXA

The Instituto de Astrofísica de Canarias (IAC) has participated in the discovery of a group of metal-poor stars shrouded in a large amount of iron dust situated in the Large Magellanic Cloud. This study involved a combination of theoretical models of the formation of dust in circumstellar envelopes with infrared observations taken with the Spitzer Space Telescope. The work includes predictions for the future James Webb Space Telescope.

Stars with masses between one and eight times the mass of the sun evolve along the asymptotic giant branch (AGB) before ending their lives as white dwarfs. It is during this rapid but crucial phase when the stars expand to huge dimensions and cool down, losing a major fraction of their mass due to strong stellar winds. The low temperature and high density of the winds provide ideal conditions for the condensation of dust grains in their circumstellar envelopes.

The dust produced by the stars in their AGB phase and expelled into the interstellar medium is important for the lives of the galaxies, because it comprises an essential component for the formation of new stars and planets. Characterising whether the dust is composed of solid state organic components or inorganic components and determining the quantity of dust is important to the astronomical community.

Astrophysical Journal Letters has published the new study, which has answers to the puzzles of a peculiar group of massive AGB stars situated in the Large Magellanic Cloud. Comparing the infrared observations made with the Spitzer Space Telescope (and predictions for the future James Webb Space Telescope) with the theoretical models developed by this group, the study reports that these stars weigh around five solar masses, were formed around 100 million years ago, and are poor in metals such as iron, magnesium and silicon. Unexpectedly, the

researchers discovered that the infrared spectral energy distributions can be reproduced only if iron dust is the principal component of their circumstellar envelopes. This is uncommon around massive AGB stars. It was previously known that such stars mainly produce silicates, magnesium and large quantities of oxygen and silicon. But this finding is even more surprising, considering the metal-poor environment of the stars under study.

The study characterizes for the first time this class of stars with unique spectral properties. "The low metallicity of these giant stars creates peculiar conditions, permitting the formation of large quantities of iron dust," explains Ester Marini, the first author of the article and a doctoral student at the Roma Tre University. "In fact, in metal-poor environments, the complex nucleosynthesis within massive AGB stars is so advanced that it burns up almost all the magnesium and oxygen, necessary to form other types of dust such as silicates."

Under these particular conditions, iron dust becomes the main component of the dust formed by these stars. "This result is an important confirmation of the theory of iron dust in metal-poor environments, already hinted at in independent observational evidence," says IAC researcher Aníbal García Hernández, a co-author of the work.

"The arrival of the James Webb Space Telescope (JWST) will open up new possibilities for investigating this case in depth," says Flavia Dell'Agli, a postdoctoral researcher at the IAC and second author of the article. "That future telescope will greatly enhance the number of resolved extragalactic AGB stars," she says, adding that the MIRI instrument on the JWST will be "ideal for identifying this class of stars in other galaxies of the Local Group."

More information: Ester Marini et al, Discovery of Stars Surrounded by Iron Dust in the Large Magellanic Cloud, *The Astrophysical Journal*

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